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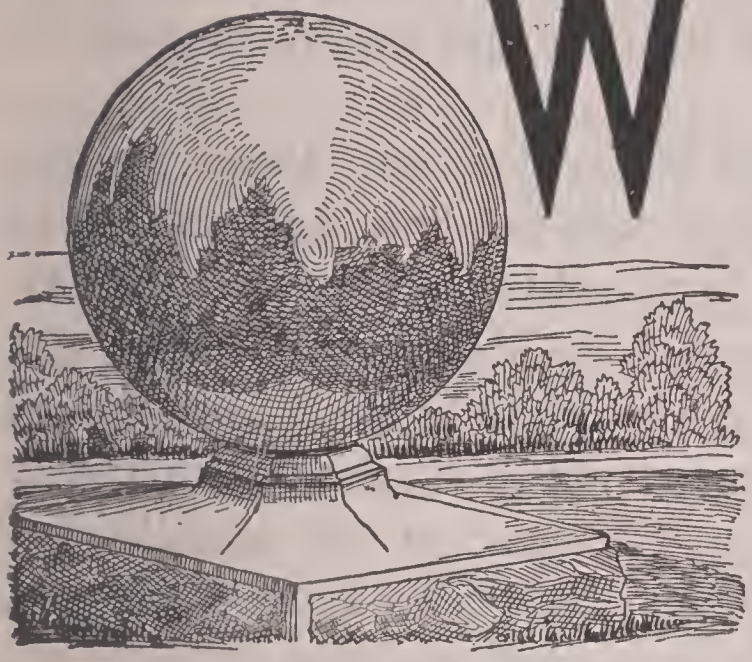
THE STORY OF GRANITE, COPPER AND ZINC

By W. F. Rocheleau



WE have already learned of the composition of granite and how it can be distinguished from other rock. The term granite as it is used in commerce includes more than it does in its strict scientific sense.

Granite in commerce means all stone that has the appearance of granite, whatever its composition may be, and includes syenite, a rock that closely resembles granite in appearance, but in its composition has hornblende in the place of mica.

Hornblende is a fibrous mineral found in a variety of forms. In syenite it occurs in crystals, usually of dark color, varying from green to black. It is firmer than mica, and makes the rock into which it enters harder and stronger. Many of the best granites are really syenites.

The name granite means granular or grain like, and is given to this rock on account of its peculiar structure and appearance. Granite is one of the oldest rocks in the earth's crust, and was once in a molten state. When it cooled each mineral crystalized separately, but all were firmly cemented together, forming the hardest and strongest rock in use.

The country may be divided into three granite sections; the eastern, middle and western. The first includes the Appalachian slope and the Atlantic coast; the second the Mississippi valley; and the third the Rocky Mountain system and Pacific slope. The eastern section is worked principally in New England and Georgia; in the middle section Missouri, Minnesota, South Dakota, Wisconsin and Arkansas have developed quarries to some extent. The western section is practically undeveloped, California being the only state worthy of mention as producing granite.

Granite occurs in most mountainous regions all over the world, but it is not suitable for quarrying in but few localities. A granite country is always rough and mountainous, with clear streams and a good soil, provided a quantity of the rock has been changed into soil. In some localities we find hills and even mountains of solid granite, as in New Hampshire, which is called the Granite State. In

other places we find bowlders scattered over the meadows or prairies and far from any parent mountain or ledge. These bowlders have a rounded shape and look like sheep lying on the ground. On this account they have been called sheep backs by some geologists.

We wonder how these rocks came here, so far from any other rock of the same kind. To understand this, we need to look to the Alps and the northern part of the Rocky Mountains and notice what is taking place there at the present time. We find the ravines and smaller valleys among these mountains filled with melting snow, forming rivers of ice called glaciers. They move slowly down the side of the mountain and carry along with them whatever stones or other deposits they may receive. The glacier melts at the bottom, and a stream of water is always running from it. As it melts, it drops the loose rocks that have come down the mountain on its surface, so we find at its foot a lot of stones resembling those found in our meadows.

These bowlders tell a story of a time when the climate of our country was very different from what it is now. The country was then a land of icebergs and glaciers. They covered the entire surface, and held everything in their frozen grasp. All plants and animals had perished, and the con-

tinent was a wild waste of ice and snow. This was before man lived upon the earth, but after the coal period.

When these masses of ice began to melt they took a sliding motion towards the south-east, and carried along all the loose rocks that had been frozen into them. As the glaciers melted they dropped their burden, and we have the bowlders scattered over the land. The rubbing against each other and on the rocks over which they moved gave the bowlders the shape they now have.

The moving of this mass of ice and stone over the outcropping ledges plowed deep furrows in some of them, and smoothed and polished others. The furrows and scratches thus formed are called striae, and point to the south-east; this tells us in which direction the mass moved.

The great masses of granite that are quarried in this country are situated in the Appalachian region, and are worked principally in New England and Georgia, with smaller quarries in Maryland, Pennsylvania and New York. The amount of granite in any one of these localities is sufficient to last the world for ages to come, so there need be no fear of its giving out in our day at least.

HISTORY.

The people of ancient Egypt were the first to

make use of granite for buildings and monuments. The stone used was a red syenite, and is very hard and durable, as the ruins of their works show. The stone was taken from quarries up the Nile and floated down to the place where it was to be used. The high degree of polish and elaborate carving with which these people finished their granite shows a great degree of skill on the part of their workmen. Their engineering skill must also have been equally good, for they moved blocks of great size and weight. In the Great Pyramid, whose base covers more than twelve acres, are found stones four feet square, and thirty feet long, and the shafts of some of their monuments were more than sixty feet in length. We do not know that they had any knowledge of steam power, or that they even used beasts of burden. To move stones of this size by the labor of men alone must have required an army of laborers and skillful management.

In the center of the Great Pyramid is a chamber forty-six feet long, twenty-seven wide, and eleven and a half high. The walls of this chamber are of polished granite of a beautiful red color, and the slabs are as long as the walls are high. The ceiling is formed of nine immense slabs of the same stone. Still standing on the banks of the Nile, not far from Cairo, is one of those monuments

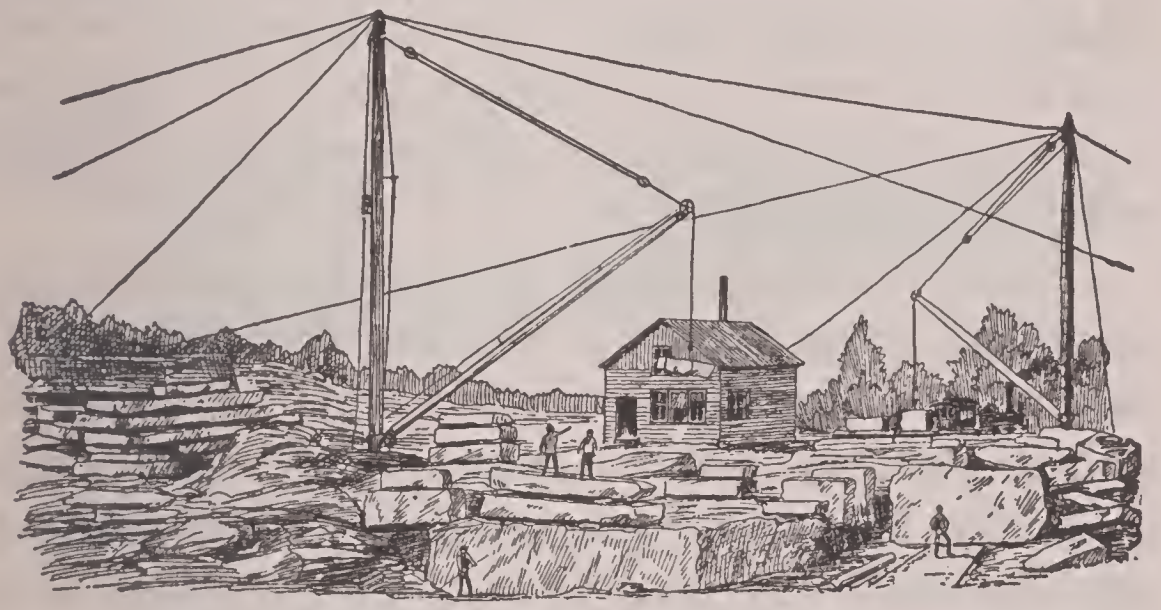
commonly known as Cleopatra's Needles. This single shaft rises sixty-eight feet above the mud which has covered its base. Some one has fitly called it the "grave stone of a buried city," for it is all that remains of that wonderful city where Joseph lived and ruled, and made himself known to his brethern. This monument was reared nearly 3,000 years before Christ, and has with-stood the ravages of time for all these ages.

Another of these monuments was a few years ago placed in Central Park, New York, and has been of great interest to the thousands of visitors who frequent the place. These stones have been diligently studied by certain historians, for the history of the time in which they were erected is written upon them in the picture writing of the Egyptians. These historians have learned to read and translate the hieroglyphics, and from them we have obtained much knowledge of the life and customs of this ancient people. That the figures are in almost a perfect state of preservation is due to the wonderful durability of the granite.

The art of polishing and carving granite seems to have been lost for centuries after the decline of Egypt. In 1856, a statue of one of the Pharaohs was brought to the British Museum. The head had been broken off, and it became necessary to

fasten it to the body by inserting a strong iron rod to hold it in place. It took the workmen six weeks to drill the holes for this rod, and they broke several tools of the best construction during the work. How do you suppose the Egyptians carved the statue?

Up to the present time the New England states have been the center of the granite industry in this country. This is not because they contain more



GRANITE QUARRY.

granite than several other localities, but because the location of their quarries has been very much to their advantage. Most of the New England quarries are so located that they can ship their stone by boat to nearly all places using it. They are also near most of the large cities of the country, so granite can be obtained from them cheaper than from any other quarries. These are important

factors in handling an article whose transportation is so expensive.

The first of these quarries was opened in Quincy, Mass., in 1820. The development of this quarry is connected with two events of national importance; the construction of the first railroad in America, and the erection of Bunker Hill Monument. The railroad extended only from the quarry to the wharf on the Neponset River, where the stone was loaded on to the boats. The rails were of wood, and the stone was carried on a platform that was suspended under the car and raised and lowered with a windlass.

Daniel Webster, in his great oration at the laying of the corner stone of Bunker Hill Monument said of it: "Springing from a broad foundation, rising high in massive solidity and unadorned grandeur, may it remain as long as Heaven permits the works of man to last, a fit emblem, both of the events in memory of which it is raised and the gratitude of those who have raised it." Such are the enduring qualities of Quincy granite that no more suitable stone could have been selected for the purpose of carrying out Mr. Webster's wish.

The first recorded use of Quincy granite is in the construction of King's Chapel, Boston, in 1752. The stone was taken from bowlders lying about the North and South Common, and so many were

used that it was feared the supply would be exhausted, and several town meetings were held to discuss the matter. It seems that the people had no knowledge of the value of granite in the immense ledges about them, nor of the means of quarrying it.

Granite had been quarried in New Hampshire before the Quincy quarries were opened, but it is with the large contract of these quarries for Bunker Hill Monument that the industry may be

THE OLD WAY.

said to have really begun. From this beginning the demand has continually increased as years have added population and wealth to the country. In 1893 the three largest granite producing states were Massachusetts, Maine, and Vermont. New York, Pennsylvania, Maryland, Georgia and Minnesota also produced considerable.

The quarries in Quincy differ from those in other localities in that they are operated by a number of small firms instead of large corporations. Some of these firms give their entire attention to quarrying the rock, others to finishing it, and still others

to the manufacture of cases in which the finished stone is shipped.

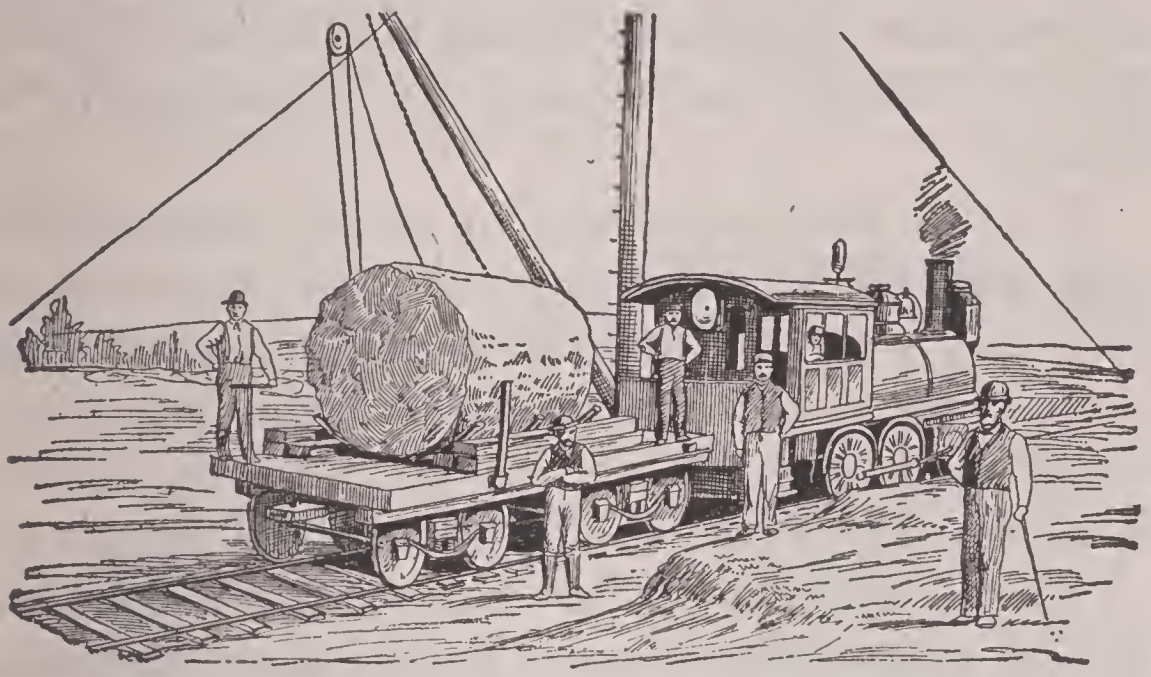
Some of the most noted New England quarries are on the islands off the coast of Maine, those on Dix, Fox and Hurricane Islands in Penobscot Bay being among the most valuable quarries in the country. Others are located along the indentations of the coast. The largest quarries in Vermont are located at Barre, and the quality of the stone is such as to place this state third in rank in 1893, when in 1889 it was ninth. Certain quarries in Connecticut furnish an excellent stone, and the "Westerly" in Rhode Island is superior for monuments and ornamental purposes.

Large deposits of granite of excellent quality are found in the northwestern part of Georgia. These quarries have been worked only a short time, but their product is in a fair way to become a strong competitor with that of the older quarries of New England.

In the middle belt, the granite of St. Cloud, Minn., is worthy of special mention as a rock of great strength and durability. Stone from these quarries has endured the highest pressure test of any in the country. The quarries at Ortonville also furnish a stone of excellent quality, and the massive Hennepin County Court House at Minneapolis is constructed of this granite. On account of the

expense in transportation the product of the Minnesota quarries has not been very generally placed on the market.

The western belt is not yet developed, but as that section of the country becomes more densely



THE NEW WAY.

populated these fields will furnish abundant building stone for all demands.

QUARRYING AND WORKING.

A granite quarry differs materially from a marble or slate quarry. The granite is usually found on or near the surface, and in many localities is cut from the side of a mountain of the solid rock. Most of these quarries can be worked for years without sinking below the level of the surrounding

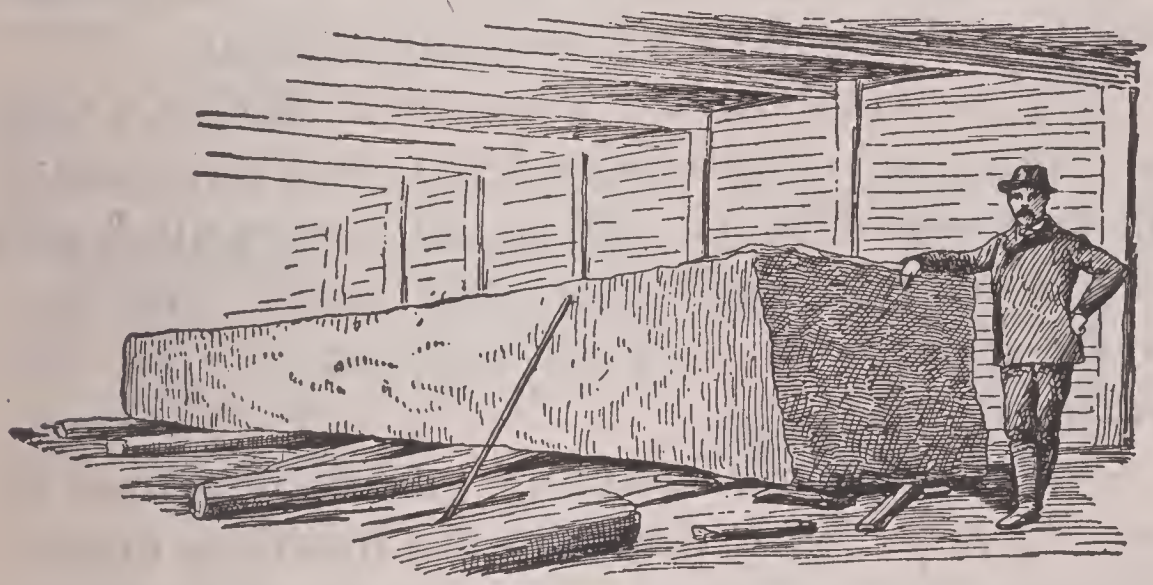
land, or at least going to a great depth, however, they frequently extend over a large area. The rock usually occurs in layers, or "sheets," as the quarrymen call them. These sheets vary in thickness from two to ten feet, and can usually be split into courses without incurring much waste, though granite cannot be worked as economically as marble.

Blasting has been found to be the most satisfactory method for loosening the rock, provided the blast is pretty sure to split it in the required direction. Care must be taken to direct the force of the explosive along the line where the stone is to be broken. There are several methods of doing this.

The first is called "lewising." Two holes are drilled a few inches apart on the line of desired fracture; the core between them is then broken out. The explosive is placed in this elongated hole, and tamped the same as an ordinary blast. If a very long fracture is required several holes are drilled along the line, and the charges are all fired at the same instant by electricity. The powder exerts the greatest force in the direction of the longest diameter of the hole, and breaks the rock as desired.

Another method is to drill a good sized hole to the desired depth, and then cut V-shaped crevices on opposite sides along the line of fracture. A plug is driven in above the powder so as to leave a

cushion of air between it and the tamping. This allows the explosive to act upon the rock more gradually, and removes the danger of shattering it into small pieces. This method is quicker, and less expensive than the other, and is usually very effective. Sometimes small holes are drilled along the line, and all fired at once. This can be done very well when the rock breaks readily and easily.



BLOCK OF GRANITE.

When blasting cannot be resorted to without great waste, small drills are used, and the holes are placed only a few inches apart. Steel lips and wedges are placed in these and the rock is split off by driving on the wedges with a heavy hammer. The old way of doing this was to make crevices in the rock and insert wooden wedges, and then cause the rock to split by wetting the wedges and making them swell. This shows how much power there is

in a small quantity of water when it is used in the right way.

Very large blocks are frequently quarried by these various methods. Sometimes a free fracture 125 or 130 feet in length is made by the blast from one lewis hole. At the Mt. Waldol quarry, Maine, a block 125x20x14 feet and containing 30,000 cubic feet, was loosened. Such results can be obtained only when the rock is free at the ends and underneath, and has room to move out in front.

A quarry in Missouri was mined; that is, a shaft was sunk and chambers, or drifts, were extended in all directions from it. These drifts were filled with explosive and the mine was fired. The blast loosened enough rock to last the firm for fifty years.

The methods for handling granite in transit resemble very closely those used in handling marble. The principal difference is that the size of the blocks is larger, and the machinery needed heavier. The cable railway is employed in many quarries to move the blocks to the cars or sheds. This is made of a strong wire cable composed of steel and copper wires. This is fastened to a high tower at each terminus. The car is suspended to this and moves on a grooved pulley. The car may be a platform on which the stone is piled, or it may be a clamp that is firmly fastened to the large blocks. A hoisting

engine is connected with another wire rope that moves the pulley along by being wound around a drum. When the car is loaded the engine is started and the stone begins its journey through the air. If the quarry is on the side of a mountain, the engine unwinds the cable and the stone moves by its own weight.

The sheds where the granite is finished present a busy appearance. Much the same machinery is

CABLE RAILWAY.

employed as in the marble mills, but a greater amount of work has to be done by hand. Granite does not split evenly, nor break with smooth surfaces, and most of the blocks have to be evened and partially worked down before they can be worked by the machines. Then many of the different styles of finish must be done by hand, though a finishing tool driven by steam or compressed air has recently come into use. This machine strikes light blows very rapidly, and can do the work of

several men. In the hands of a skillful operator it is very effective.

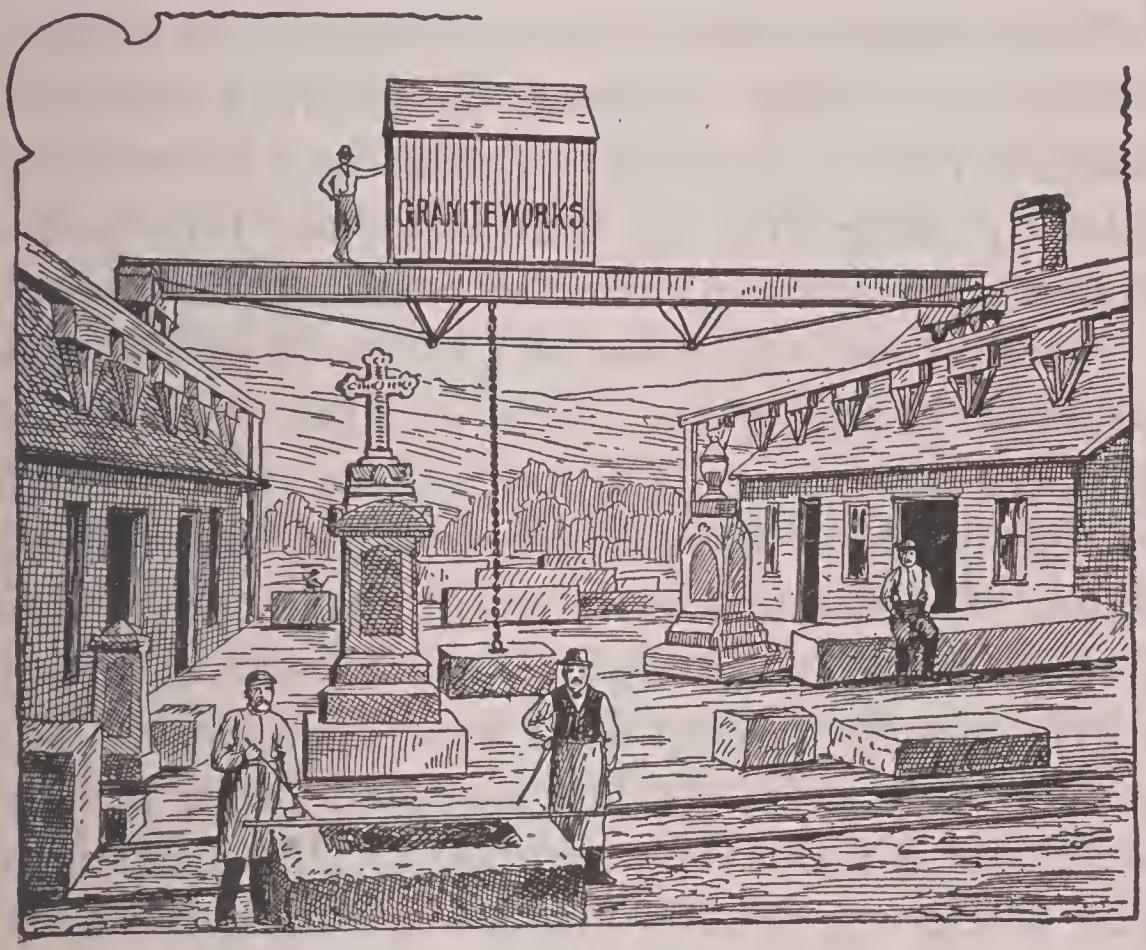
All hand or machine finished surfaces have to be ground before they can be polished. The grinding is done with a rapidly revolving steel disk made of rings placed one within another. The disk revolves horizontally, and is so arranged that it can be brought in contact with every part of the surface. The grinding is done by water and steel emery or sand. Granite is polished with a buffer and putty powder the same as marble. Lathes are used for turning pillars and shafts, and special devices are employed for polishing curved surfaces.

Granite is so hard that it requires the best of tools and strongest machinery to work it successfully. Much more time is also needed to work a piece of granite than a similar piece of marble. On account of this granite is more expensive than most other stones in general use.

VARIETIES AND USES.

Of all stone quarried in the United States, granite can be applied to the greatest number of uses. It is so hard that it posesses great strength, and so durable that the action of the weather has no effect upon it. It can be carved into any form, and finished in any style of surface. It takes a higher

polish than marble, and has nearly as great a variety of colors. The colors range from almost white in the grays to blue and nearly black, and from light pink to dark red. Occasionally a variety with a greenish tint is found, but it is not common.



Granite is employed for public buildings and other large structures in cities for which its massive appearance and great strength make it suitable. Some quarries are pretty well known over the country by the public buildings for which they have furnished stone. A good illustration of this

is the Vinal Haven Quarry in Maine. Granite from this quarry is found in the buildings of the State and War departments at Washington; the Auditorium and Pullman Building, Chicago; the Federal Building, Brooklyn, and the polished granite surfaces in the State House at Indianapolis.

The readiness with which granite yields to treatment, enables the architect, by different styles of finish to obtain pleasing contrasts with harmony of color by using only one kind of stone. This makes this stone especially suited to building purposes.

Another extensive use of granite is in the construction of streets and roads. It has been found that the busiest streets in great cities stand longest and serve their purpose best when paved with stone. Granite makes an excellent paving stone because it is hard enough to stand wear well and brittle enough to keep from wearing smooth. The paving block industry has assumed large proportions, and is quite remunerative to the companies. The blocks are usually four and a half inches wide, six or seven deep, and eight or twelve long. They can often be cut from what would otherwise be waste, but are sometimes worked directly from the sheets. The sheets are broken by hammers into strips the width of the block, and these are then broken into blocks. A successful workman on paving blocks must be able to tell at a glance in

what direction the stone will split the most readily, and must be skillful in the use of his hammer.

The manufacture of curbing stones forms a good part of the business of some quarries. Curbstones are from six to twelve feet long, six to eight inches wide, and about two feet deep. The stones are dressed at the ends so as to make a good joint, and on the top and for a few inches on the back next to the walk. When we think of the miles of curbing in our cities, we can see that this branch of the granite industry alone would make a large business.

Granite is also used in paving streets where a smooth surface is required. For this purpose the stone is either broken into small pieces by hammering, or in crushing machines when a small size is desired. The crushed rock is then mixed with a cement and rolled down under a heavy pressure. When the cement hardens, we have one of the finest road surfaces that can be made.

A few years ago all the granite monuments in our cemeteries came from Scotland. The stone is of a rich red color, very hard, and takes a high polish. It was soon discovered that American granite could be polished as well as that brought from Scotland, and now only a few Scotch monuments are purchased. Granite furnishes excellent material for monuments on account of its durability and the great beauty of its polished surface.

We also find granite supplanting marble for outdoor statuary in our public parks and many of the largest monuments. Some of these monuments are among the most beautiful works of art to be seen in the country, and their shafts will rival in size and beauty those of the Ancient Egyptians mentioned in the first pages of the chapter. The Soldiers' and Sailors' Monument in Boston Common, and the monument erected at Plymouth, Mass., to commemorate the landing of the Pilgrims, are among the most celebrated. As we noticed how the Egyptians wrote their history in stone, let us look at this monument and see how the same thing is done now.

The base of the monument is forty-five feet high and supports a statue of thirty-six feet. The main pedestal is in the form of an octagon with four large and four small faces; from the small pedestal project four wing pedestals, or buttresses.

The statue on the main pedestal is a majestic figure of Faith. One foot is firmly planted on Plymouth Rock. The left hand holds a Bible and the right hand points towards Heaven. The face, which has an expression of sublime trust, is bent downward. The length of the outstretched arm is nineteen feet and ten inches; the head at the forehead measures thirteen feet and seven inches, and

the arm just below the short sleeve, six feet and ten inches in circumference.

On each of the four pedestals are seated figures which represent the principles by which the Pilgrims were guided in founding the state. The figures are Morality, holding the Decalogue in one hand and a scroll of Revelation in the other; Law, with Justice and Mercy; Education, with Wisdom on one side and Youth led by Experience on the other; and Freedom, with Peace under her protection and Tyranny hurled down from power.

Upon the faces of the projecting pedestal are reliefs representing scenes from the history of the Pilgrims, the departure from Delft-Haven, the signing of the compact, the landing at Plymouth, and the first treaty with the Indians. This wonderful story in stone is told as eloquently and even more beautifully than are those chiseled by the Egyptian sculptor upon his ancient obelisks.

SUGGESTIONS:—See how many different kinds of granite you can find, and explain the different colors.

How can you account for the shape and smoothness of granite pebbles?

Compare a granite and a marble monument and describe the difference in the structure of the rock.

COPPER AND ZINC.

In the eastern part of the Mediterranean Sea is situated a large island called Cyprus. Here many centuries ago the Romans were accustomed to mine a bright red metal, which they named Cuprum, from the name of the island. To-day we call this same metal copper. This incident shows that copper was known to the Romans, who used it in a pure state for coin, and when alloyed with tin, for shields, armor plates and statues.

But copper was known as a useful metal long before the time of the Romans. We are told that Cheops, the builder of the great pyramids in Egypt, worked a copper mine in the Sinai peninsula, and that the Egyptians had a process of hardening copper so that they could make out of it tools for cutting stone and other hard substances. Many copper utensils have been discovered among the ruins of ancient Babylon, and in the book of Job, which some scholars believe to be the oldest book of the Bible, we read that "copper was molten out of stone."

Copper was used by the native races of America long before this continent was discovered by white men. When the Spaniards conquered Mexico in 1521 they found the Aztecs using axes and other

tools made of copper, and the Incas of Peru were found in possession of similar implements a few years later. Both nations had large copper mines in their countries, which they worked with success.

Copper, like gold, is found pure in some localities, were it occurs in veins and pockets in the surrounding rock. This is called native copper, and is the source of about one-fourth of the supply produced in the United States. The larger amount is, however, extracted from ores, most of which are compounds of copper and sulphur, or copper and carbon dioxide. The latter form carbonates of copper, and are among the most beautiful rocks known. One variety, called azurite, is a beautiful blue crystal suitable for ornaments, but it is not found in sufficiently large quantities to make it a source of copper. The other carbonate is called malachite. It has a mottled green appearance and is hard enough to take a polish like marble. Malachite is extensively quarried in the Ural mountains, and is used in making mantels, table tops, and many smaller ornamental articles, such as matchsafes, inkstands and the like. When polished it is very beautiful, and objects made from it are so expensive as to place them above the means of any but the wealthy. Inkstands of malachite often cost from $16 to $20, and table tops sometimes are valued as high as $2000. It is needless to say that the best quality

of malachite is not used in the production of copper, as it is much more valuable for other purposes. A number of carbonates of inferior quality, however, constitute an important source from which copper is obtained.

The compounds of copper and sulphur form the most abundant ores. These are easily recognized by their brass-like color and metallic luster. This ore is often known as yellow copper and copper pyrites. It is very brittle and often so soft that it can be cut with a knife. Another variety, containing more sulphur and called copper glance, is also an important source of supply. Sometimes iron is combined with the copper in these sulphur ores, and when this occurs the rock reflects various tints of purple and is called peacock copper or horse-flesh ore.

COPPER MINES.

While copper is very generally distributed over the earth, it occurs in large quantities in only a few localities. In Europe there are several important mines in Spain, which have been worked for centuries; others are found in the Ural mountains in Russia, and others in Norway and Sweden, Saxony, France, and in Cornwall and Devonshire, England.

However interesting it might be to learn the history of the copper mines of other countries, we are

more particularly interested in those at home, both because they are connected with the industrial development of our country, and because they are the largest in the world. The great copper mines of the United States are located in Michigan, Montana and Arizona. Considerable copper is obtained from the gold and silver mines of Colorado and California, in connection with the smelting of these ores, and small mines are also found in a few states through which the Appalachian mountains pass, but the three states first named produce nearly all the copper mined in the country.

If you look on the map of Michigan, you will see a small point of land projecting into Lake Superior from about the middle of its south shore. This is Keewenaw Point; it is a little more than 60 miles long and about 20 wide in its widest place. On this point are located the most interesting copper mines in the world.

The mines on Keewenaw Point have been worked since 1845, and from 1874 to 1883 they supplied more than one-half the copper produced in the United States. The metal occurs as native and is found in veins and pockets inclosed in a conglomerate rock. Occasionally the most beautiful crystals are found encased in a pure milk-white quartz. These are highly prized for cabinet specimens. There are six large mines now in operation, and

one of them, the Calumet and Hecla, has obtained a world-wide reputation on account of its great value and the extent of its operations. The miners have been constantly seeking lower levels, and now the

UNDERGROUND IN THE CALUMET AND HECLA MINE.

main shaft has a vertical descent of more than 6,000 feet, by far the deepest in the world.

The operation of these mines requires the most powerful machinery that can be constructed for such purposes, and the city of Calumet, which has

been built up around the shafts, is a city of tall chimneys and large engines, used in ventilating the mines, pumping out the water and hoisting the ore. Since a full description of how all this is done has been given in describing the operation of a coal mine, we do not need to repeat it here.

The Montana mines are located at Butte and at Anaconda, which like Calumet are mining cities. These mines are more like quarries and are not noted for their depth. The ore is copper pyrite, copper glance and peacock copper, and occurs in granite. The Montana mines have been developed within the last few years and now produce the largest amount of copper of any in the country. The Arizona mines are located in the southwestern part of the territory in the Clifton, Bisbee and Globe districts. The ore is either a carbonate or an oxide. These mines have been worked since 1883 and now produce about one-fourth of the output of the country.

SMELTING.

The method of treating copper ore depends upon its composition. Where the ore contains only native copper, like that of the Lake Superior region, the treatment is very simple. The ore is crushed in heavy stamp mills, and the copper separated by washing. The crude metal is then sent to the smelters, melted and run into ingots, which are

ready for shipment. Since copper is smelted without difficulty no such elaborate furnaces are required as in the reduction of iron ore.

Ores containing sulphur are subjected to a complex treatment. Usually the ore is broken into

SMELTING WORKS—LAKE LINDEN.

pieces about the size of anthracite coal used in stoves. It is then roasted to expel the sulphur, which passes off in the form of gas. As the sulphurous gas kills all vegetation which it touches, regions near the smelting works present a desolate

appearance. After being roasted the ore is melted, producing "matte," a compound of copper, sulphur and whatever other metals the ore may contain, but having from 50 to 65 per cent of copper. The matte is usually remelted and placed in Bessemer converters, where the sulphur and arsenic, if present, are expelled by a process similar to that used in making Bessemer steel.

The result of this process is usually an alloy of gold, silver and copper. The alloy is now dissolved in acid and the solution treated with a powerful electric current. The pure copper collects around one wire conveying the current, and known as the negative pole, and the gold and silver settle on the bottom of the vessel as a brown mud.

PROPERTIES AND USES

Copper has a peculiar red color and a disagreeable odor. When exposed to the air it oxidizes and turns brown, but this does not seem to work any injury to the metal. It is about nine times as heavy as water, and among the common metals ranks next to iron in hardness and strength. Copper is very ductile and malleable; next to silver, it is the best known conductor of electricity; it is also one of the best conductors of heat. When taken into the system it is one of the most fatal poisons.

The uses of copper are many, and they are being constantly extended. During the last quarter of the nineteenth century the application of electricity to so many purposes created such a demand for copper as greatly to advance the price.

Copper nails, bolts and plates are extensively used in the building of ships. Another important use of the pure metal is in making electro-plates for printing. Pure copper has also been used for coin ever since money was known.

Some of the numerous alloys of copper are brass, gun metal, bell metal, and many kinds of bronze. An alloy of copper, zinc and nickel is known as German silver.

The United States now leads the world in the production of copper. The annual output amounts to more than a billion pounds; coming from the Lake Superior mines, the Montana mines, the Arizona mines, and certain small mines.

ZINC

Zinc ore is always in the form of rock, and the makers of brass and bronze among the ancient Babylonians, Greeks, Romans and other peoples discovered that by reducing this rock to a powder, and mixing it with molten copper, brass could be made, and for many centuries this process was in use in the manufacture of brass and bronze.

Pure zinc was first manufactured for use in

1721. In 1850 it was manufactured for use in New Jersey, and now the United States manufactures nearly one-fourth of the zinc produced in the world.

The oldest zinc mines in the country are in New Jersey and in Lehigh Co., Pennsylvania. Later, deposits of ore were discovered near Knoxville, Tenn., in Arkansas, in the southwestern part of Wisconsin, and in Missouri and Kansas.

SMELTING

Zinc ores are compounds of zinc with sulphur, carbon or oxygen, and the process of extracting the metal from them is a very complicated and difficult one. The sulphides and carbonates are first roasted to drive off the sulphur, carbonic acid and water. The roasted ore is then crushed fine and mixed with fine coal or coal dust in proportions of about six parts of ore to four parts of coal. This mixture is placed in a furnace made specially for the purpose, and heated.

The zinc melts and changes to vapor at a lower temperature than is necessary to liberate it from the ore, hence the process is called distillation. The zinc rises in the form of vapor, which passes out through tubes in the top of the furnace and is collected in chambers having a temperature low enough to change the vapor to liquid zinc, which is gathered in a tank on the bottom of the chamber.

The molten metal is drawn off and cast into ingots.

Zinc obtained from the smelter usually contains more or less sulphur and arsenic, and needs to be redistilled before using. When purified it is melted and worked into the form desired.

PROPERTIES AND USES

Zinc is of a grayish-white color, but if scraped or filed the exposed surface is nearly as white as silver. The degrees of hardness and brittleness depend entirely upon the temperature. When cold, zinc is hard and very brittle, but on warming to about the temperature of boiling water, it becomes soft and malleable and can be rolled into sheets. If the temperature is raised, however, the brittleness returns.

The most common use of zinc is in the form of sheets, which are employed for numerous purposes familiar to all. Other extensive uses are in making parts of galvanic batteries, and galvanized iron.

The manufacture of zinc cannot be considered as one of the important industries of the United States, for the value of the entire output will not exceed $75,000,000 a year, but the relation which zinc sustains to other metals that form the basis of some of our greatest industries is such as to make a knowledge of its properties and uses necessary.

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